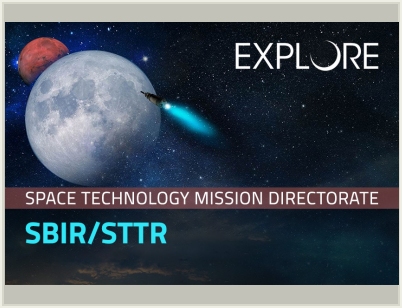
Radiation-Hardening of Best-In-Class SiGe Mixed-Signal and RF Electronics for Ultra-Wide Temperature Range, Phase II

Completed Technology Project (2015 - 2017)

Project Introduction

Innovative, reliable, low-power, and low-noise electronics that can operate over a wide temperature range and high radiation are critical for future NASA missions. Silicon Germanium (SiGe) is a robust IC technology with superior electronic properties, resilience to harsh environments, and moderate cost of Si fabrication that can dramatically reduce mission size-weight-and-power and cost (SWaP-C). IBM's 90-nm state-of-the-art 9HP SiGe BiCMOS platform delivers higher performance and lower power, and enables highly integrated (sub-) millimeter wave applications not possible with earlier SiGe nodes. It is therefore, a prime candidate for designing future mixed-signal/RF electronics for NASA. Currently, however, there are few wide-temperature/radiation data, models, and circuits in this platform. Advanced computational tools are essential to support design and assess performance of 9HP-based electronics. This project aims to develop novel Radiation Hardened By Design (RHBD) analog/mixed-signal and RF ICs in the best-in-class 9HP technology. In Phase I, CFDRC and Georgia Tech investigated the electrical performance of 9HP SiGe HBTs across an ultra-wide temperature range. HBT-based circuits were examined for single-event transient (SET) response via irradiation testing and detailed mixed-mode simulations. RHBD techniques were identified for further evaluation. In Phase II, we will select representative 9HP-based circuits from high-frequency and general purpose (low-frequency analog/mixed-signal) applications, and perform electrical and radiation response characterization (DC and RF) across a wide temperature range, via testing and mixed-mode modeling. RHBD techniques will be implemented and verified via modeling, and promising designs will be fabricated, tested, and delivered to NASA. Technology scaling effects on extreme environment performance of SiGe HBTs/circuits across different generations (9HP vs. 8HP vs. 5AM) will be evaluated to support design/trade-off analyses



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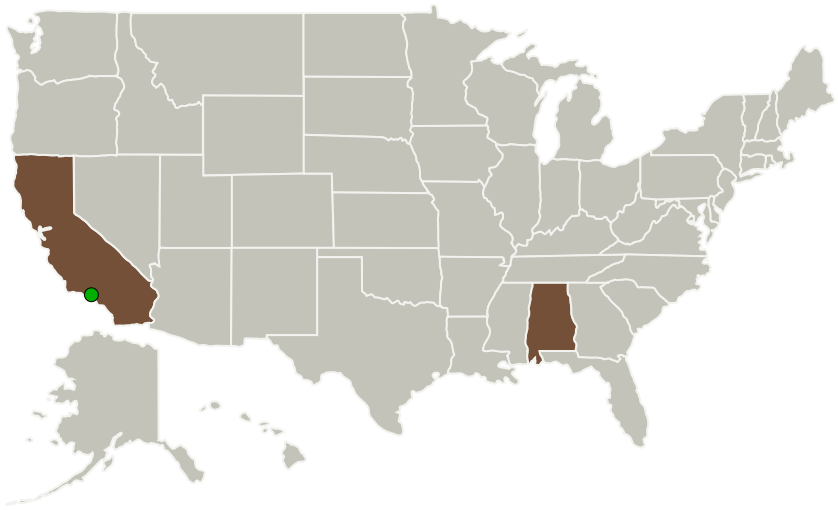
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
Alabama	California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

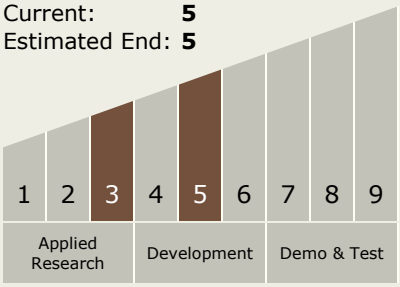
Carlos Torrez

Principal Investigator:

Ashok Raman

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



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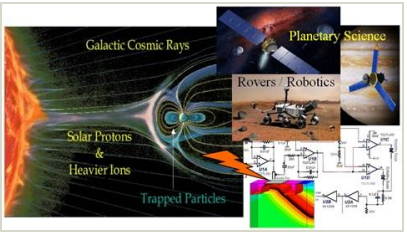
Images



Briefing Chart
Radiation-Hardening of Best-In-Class SiGe Mixed-Signal and RF Electronics for Ultra-Wide Temperature Range Briefing Chart *(https://techport.nasa.gov/image/125803)*

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.2 Electronics

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System